PATENT SPECIFICATION

580,806

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PROVISIONAL SPECIFICATION

Improvements in Compressor, Turbine and like Blades

I, (Dr.) ALAN ARNOLD GRIFFITH, F.R.S., a British Subject, of "Rose Cottage", Quarndon, Derby, in the County of Derby, do hereby declare the nature of this invention to be as follows:—

This invention relates to blades for compressors, turbines and the like of the reaction type. It is customary to make such blades as smooth as is practicable to reduce fluid-friction losses with the object of improving the efficiency. With laminar flow, however, of the gas over the blade, the boundary layer is caused to flow only by the fluid friction of adjacent layers on it. There is a smooth flow over a portion of the surface, but since the flow takes place against a pressure gradient, the fluid then breaks away and forms a large eddy over the rear half of the blade; this is undesirable, and according to the present invention, the blade-surface, instead of being smooth, is roughened to an extent sufficient to disturb the boundary layer more or less uniformly so as to produce small eddies in it. The gas particles of the boundary layer are, therefore, displaced into adjacent layers and the desired velocity is thereby more effectively imparted to them.

The roughened surface may be produced by a special treatment, but it has been found that the desired result can be obtained by using sand-cast blades which are not given any polishing or smoothing treatment.

In a practical example, the blades are cast individually of a high nickel-chrome steel, or an 80:20 nickel-chromium alloy or other material suitable to the working conditions of the blade. Each is cast individually to eliminate undesirable temperature effects in the casting and to ensure uniformity, and the blades are machined only at the roots, or roots and tips where they are mounted in or secured to the rotor.

This invention is of particular advantage when applied to the blades of a compressor, but is of value in some conditions of operation in a turbine, whether it is a steam-turbine or a gas-turbine as described in my concurrent secret patent application No. 4699/41.

Dated this 21st day of May, 1941.
BOULT, WADE & TENNANT,
111 & 112, Hatton Garden, London, E.C.1,
Chartered Patent Agents.

COMPLETE SPECIFICATION

Improvements in Compressor, Turbine and like Blades

I, (Dr.) ALAN ARNOLD GRIFFITH, F.R.S., a British Subject, of "Rose Cottage", Quarndon, Derby, in the County of Derby, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to blades for compressors or turbines and the like of the reaction type. It is customary to make such blades as smooth as is practicable in order to reduce the fluid-friction losses and improve the eficiency. With laminar flow of the gas over the blade, however, the boundary layer is caused to flow only by the fluid-friction of adjacent layers upon it, and according to the present invention the blade surface, instead of being smooth, is roughened to an extent sufficient to disturb the boundary layer more or less uniformly and produce small eddies in it but not to disturb the main flow of gas beyond the boundary layer; the gas particles of the boundary layer are thereby displaced into the adjacent gas layers and the desired velocity is thereby more effectively imparted to them.

In the accompanying drawings:—

Figure 1 illustrates the gas flow over a compressor blade having a smooth surface, and

Figure 2 similarly shows the gas flow

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over a blade roughened in accordance with the present invention. It is to be understood that these drawings are purely illustrative and are not to be taken as in any way defining or delimiting the invention.

Referring first to Figure 1, the blade 10, shown in section, may be of any known or suitable section and the gas flow over the forward part of its surface is indicated at 11, 12 as a smooth laminar flow. Under these conditions, however, the boundary layer 11 is caused to flow only by the friction existing between it and the adjacent layers since the surface 15 of the blade is made as smooth as is practicable, and since this flow takes place against a pressure gradient the gas in the boundary layer breaks away from the surface of the blade and forms a large eddy or turbulent flow over the rear half of the blade. The point of break away is indicated at 13 and the area of eddying flow reduces the capacity and the efficiency of the compressor.

A compressor blade in accordance with the present invention is illustrated at 16 in Figure 2, and its surface 17 is rough compared with the smooth surface of the known types of blade illustrated in Figure 1. The effect of this roughness is that the boundary layer 18 of the gas is disturbed by the production of small eddies in it as indicated at 19, this effect being substantially uniform over the whole surface of the blade. The result is that the particles of gas in the boundary layer are driven away from the surface 17 of the blade into the adjacent layers of gas and thereby acquire more effectively the desired flow, so that a generally smooth flow is obtained as indicated at 20, separated from the surface of the blade by the very thin layer 19 of disturbed flow; the final result is that the capacity and efficiency of the compressor are increased.

The roughening of blades to produce the effect described above may be achieved by a special treatment of the surface, but it has been found that the desired result can be obtained by using sand-cast blades which are not given any polishing or smoothing treatment. The blades are preferably cast individually from a material suitable to the working conditions of the blade, such, for example, as a high nickel-chrome steel or 80:20 nickel-chromium alloy. Each blade is cast individually in order to eliminate undesirable temperature effects in the casting and to ensure uniformity, and they are machined only at the roots or roots and tips where they are mounted in or secured to the rotor.

This invention is of particular advantage when applied to the blades of a compressor, but it is also of value in some conditions of operation in a turbine whether it be a steam-turbine, or a gas-turbine as described, for example, in my concurrent Patent Application No. 4699/41.

It is desired to emphasize, as mentioned above, that the accompanying drawings are purely diagrammatic and illustrative and that such details as the thickness of the gas layers, and location and extent of the areas of disturbed flow are not to be taken as represented to scale.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:—

1. A blade for a compressor, turbine or the like, whereof the surface is sufficiently rough to disturb the boundary layer of gas flowing over it but not the main flow of gas beyond the boundary layer, for the purpose set forth.

2. A blade according to claim 1 which is formed as a sand-casting and has its operative face left in its sand-cast form.

3. A blade for a compressor, turbine or the like substantially as hereinbefore described with reference to the accompanying drawings.

4. A compressor whereof some or all of the blades are roughened substantially as and for the purpose hereinbefore described.

Dated this 19th day of February, 1942.

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Chartered Patent Agents.

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Fig.1.

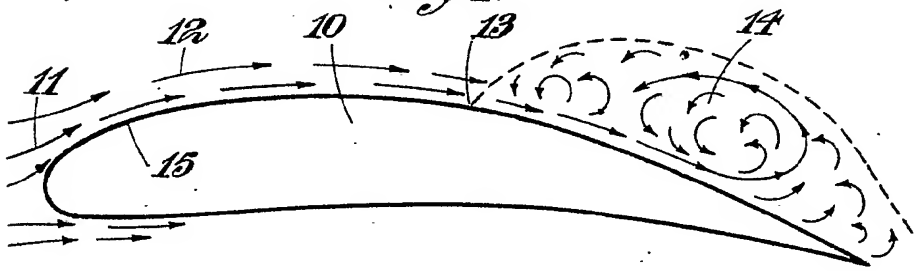

Fig.2.